PHYTOTOXICOLOGY ASSESSMENT SURVEY IN THE VICINITY OF THE EXOLON COMPANY, THOROLD - 1990

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INTRODUCTION

On August 8 & 9, 1990, a vegetation assessment survey was conducted by Phytotoxicology staff in the vicinity of the Exolon Company, Thorold. The survey was requested by the MOE West-Central Region because of public concerns about odours and particulate emissions from the company.

At the time of the survey, the Exolon Company manufactured silicon carbide and aluminum oxide. The emissions of primary concern were sulphur compounds (H_2S, SO_x) and particulate. Coal and silica sand are the raw materials used to produce silicon carbide. Sulphur emissions result from the burning of coal in the furnaces. The furnaces producing aluminum oxide from bauxite are possibly the sources of fugitive particulate emissions. The preceding information was provided by MOE Welland District staff.

The Exolon plant site was neighboured at the east limit by a narrow hydro-right-of-way and residential properties bordering Queen Street. A residential area also was situated to the north. The company's west limit was abutting a railroad. Beyond the railroad, an undeveloped field with scrub vegetation extended west through to Collier Road. West of Collier Road was a relatively new residential community and some commercial properties. Some residential and commercial or industrial properties, including an alum manufacturing plant, were situated between Queen Street and Collier Road in the vicinity of the company's south limit (see attached figure).

INSPECTIONS AND SAMPLING

On August 8 & 9, 1990, foliar inspections for SO_x-type injury were conducted on trees, shrubs, flowers and garden crops on residential properties along Queen Street to the immediate east, and along Bolton Avenue to the north of Exolon.

In addition, Manitoba and/or silver maple foliage was collected for chemical analysis from exposed branches at eight stations (1, 2, 4, 5, 6, 10, 11, 12) established close to Exolon, as well as from five sites (3, 7, 8, 9, 13) more remote. At the closest site (1), foliage also was sampled from the opposite side of the tree crown facing Exolon. The foliage sampling to the east and north was conducted at increasing distance from the Exolon plant site. Foliage collection Site 2 was close to the MOE's air monitoring station. Foliar inspections were conducted at all collection sites.

Also sampled at Site 1 were leaves with a greyish-black surface deposition. This sample was collected for identification of the particulate deposition.

All samples were returned to the Phytotoxicology Processing Laboratory. The foliage samples for chemical analysis were oven dried, ground and stored in glass jars. They were then submitted to the MOE Laboratory Services Branch for analysis of numerous elements (mostly metals), including aluminum and sulphur. The sample of particulate deposition was submitted to the Laboratory Services Branch for microscopic analysis.

RESULTS:

Observations

The inspections in early August revealed greyish-black particulate on the surface of exposed foliage at six collection sites (1, 2, 4, 5, 6 & 11) in the immediate area of the company. The heaviest deposition was observed at Site 1, which was the closest site to the east of Exolon. This site was located on the hydro right-of-way beside the Exolon entrance and parking lot. Trace to very light deposition was observed at the other five affected sites.

Examinations of vegetation on residential properties in the vicinity of the company did not reveal any foliar injury typical of sulphur (SO_x) emissions.

Particulate Identification

Electron microscopy revealed that individual particles of the particulate deposits on the leaves were about 10 micrometers in diameter. Some combustion products were present in the form of iron spheres, wood char, glassy spheres (likely aluminum and/or silica) and graphite material. The lightly coloured material consisted primarily of aluminum, with lesser amounts of silicon, iron and titanium also being present.

Analytical Results

In the attached table, the foliar concentrations detected at sites close to Exolon are compared with the more remote results, and with the Upper Limit of Normal (ULN) rural guidelines developed by the Phytotoxicology Section. A rural ULN has been established for all elements except manganese and strontium. The derivation and significance of the MOE "ULN" contaminant guidelines are discussed in the attached appendix.

Aluminum (Al), Chromium (Cr), Fluoride (F) and Iron (Fe)

Foliar concentrations of Al, Cr, F and Fe displayed a decreasing pattern with increasing distance to the east and north. Site 1, the closest site to the east of Exolon, had the highest levels. The pattern of higher levels in the exposed foliage at this site further indicated that Exolon operations are resulting in emissions of these elements. At Site 1, foliar levels of Al (700 ppm), Cr (12 ppm), F (59 & 20 ppm) and Fe (540 ppm) were elevated above remote levels and exceeded the respective ULN guidelines (500, 8, 15 & 500 ppm). Fluoride also was slightly elevated at Site 4 (19 ppm) and Site 11 (25 ppm). However, as the concentrations of these elements even at the most contaminated site (Site 1) were not appreciably elevated, Exolon would appear to be a relatively minor emission source of Al, Cr, F and Fe.

Other Elements - Cadmium (Cd), Chloride (Cl), Cobalt (Co), Copper (Cu), Lead (Pb), Manganese (Mn), Molybdenum (Mo), Nickel (Ni), Sodium (Na), Strontium (Sr), Sulphur (S), Vanadium (V) & Zinc (Zn)

Several of these elements also exhibited a pattern of higher levels on the exposed side at Site 1 or a tendency towards decreasing concentrations with distance. However, comparisons with the remote levels and the ULN guidelines did not indicate that Exolon was a significant source of any of these elements. In all cases (excluding Cl), even the highest foliar concentrations found in the vicinity of the company were still within a normal background range relative to the rural ULN guidelines. The exceedances of the foliar rural Cl ULN at some sites were likely related to winter road salting rather than emissions from Exolon.

Summary

In summary, the 1990 phytotoxicology survey around Exolon revealed above-normal foliar levels of Al, Cr, F and Fe at sites close to the company. However, as levels of these elements even at the most contaminated site (Site 1) were not appreciably elevated, Exolon emissions would appear to be a minor source of these elements. Greyish-black surface deposition was detected on foliage at sites close to the company, with the heaviest deposition being observed at Site 1, immediately east of Exolon. The elements Al, Fe, Si and Ti were identified in this material. This would have contributed to the elevated Al and Fe levels found in tree foliage in the survey area. The inspections of vegetation in the survey area did not reveal any foliar injury typical of gaseous sulphur (SO_x) emissions.

Concentrations of Metals and Other Elements Detected in Tree Foliage in the Vicinity of Exolon, Thorold - August 1990

Site	Distance+/ Direction	Maple Species	Average* Concentration (ug/g, dry wt.)					
			Al	Cd	Cl	Co	Cr	Cu
Sites Closest to Exolon								
1	95 m NE	Manitoba	700	<.1	850	0.3	12	8
		Prot**	88	<.1	420	<.2	3	7
2	190 m NE	Manitoba	170	<.1	840	0.3	5	7
		Silver	155	<.1	140	<.2	4	8
4	27[illegible] m NE	Silver	240	0.1	490	<.2	4	9
5	220 [illegible] NNE	Silver	225	0.1	2900	<.2	2	13
6	230 m NNW	Silver	92	<.1	720	<.2	2	15
10	250 m W	Silver	113	<.1	270	<.2	1	11
11	120 m SE	Silver	240	0.1	1400	<.2	2	9
12	360 m SW	Silver	160	0.1	1450	<.2	1	9
		MEAN	233	<.1	1007	<.2	4	10
Sites More Remote								
3	500 m NE	Manitoba	130	<.1	1050	<.2	2	7
		Silver	160	<.1	1750	<.2	3	9
7	470 m N	Silver	78	0.1	2550	<.2	1	5
8	930 m N	Manitoba	79	0.2	660	<.2	1	12
		Silver	98	<.1	360	<.2	1	11
9	1.2 km NE	Manitoba	105	<.1	5800	<.2	1	6
		Silver	99	0.1	4350	<.2	1	6
13	>2 km SSW	Manitoba	59	0.1	650	0.2	1	5
		Silver	32	0.1	650	<.2	1	7
		MEAN	93	<.1	1980	<.2	1	8
ULN GUIDELINE***			500	1	1500	2	8	20

Continued .....

Concentrations of Metals and Other Elements Detected in Tree Foliage in the Vicinity of Exolon, Thorold - August 1990

Site	Distance+/ Direction	Maple Species	Average* Concentration (ug/g, dry wt.)					
			F	Fe	Pb	Mn	Mo	Ni
Sites Closest to Exolon								
1	95 m NE	Manitoba	59	540	3	43	0.4	3
		Prot**	20	235	<1	32	0.3	2
2	190 m NE	Manitoba	14	260	2	49	<.2	2
		Silver	10	230	1	25	<.2	1
4	270 m NE	Silver	19	270	3	17	0.3	2
5	220 m NNE	Silver	15	245	2	31	0.3	2
6	230 m NNW	Silver	6	160	1	62	0.3	1
10	250 m W	Silver	5	180	2	24	<.2	1
11	120 m SE	Silver	25	325	2	75	0.4	2
12	360 m SW	Silver	5	165	1	25	<.2	1
		MEAN	18	264	2	39	0.2	2
Sites More Remote								
3	500 m NE	Manitoba	12	190	2	26	<.2	2
		Silver	11	275	2	54	0.3	2
7	470 m N	Silver	5	145	2	61	<.2	1
8	930 m N	Manitoba	5	140	2	31	0.5	2
		Silver	5	205	1	120	<.2	1
9	1.2 km NE	Manitoba	5	190	2	33	<.2	2
		Silver	6	175	2	51	<.2	1
13	>2 km SSW	Manitoba	3	130	1	39	0.4	2
		Silver	3	120	1	66	0.3	1
		MEAN	6	174	2	53	0.2	2
ULN GUIDELINE***			15	500	30	-	1.5	5

Continued.....

Concentrations of Metals and Other Elements Detected in Tree Foliage in the Vicinity of Exolon, Thorold - August 1990

Site	Distance+/ Direction	Maple Species	Average* Concentration (ug/g, dry wt.)				
			Na	Sr	S	V	Zn
Sites Closest to Exolon							
1	95 m NE	Manitoba	47	38	2250	3	29
		Prot**	17	33	2200	0.5	28
2	190 m NE	Manitoba	32	68	2100	<.5	25
		Silver	11	13	1700	1	29
4	270 m NE	Silver	10	13	1800	3	36
5	220 m NNE	Silver	22	25	2900	2	57
6	230 m NNW	Silver	11	18	2150	<.5	48
10	250 m W	Silver	17	18	1850	<.5	51
11	120 m SE	Silver	16	19	2450	1	53
12	360 m SW	Silver	14	28	2100	<.5	38
		MEAN	20	27	2144	1	41
Sites More Remote							
3	500 m NE	Manitoba	25	47	2150	1	17
		Silver	15	28	2400	1	53
7	470 m N	Silver	10	25	1700	<.5	37
8	930 m N	Manitoba	21	47	2050	<.5	14
		Silver	13	27	2200	<.5	58
9	1.2 km NE	Manitoba	20	80	1850	<.5	23
		Silver	13	25	1350	<.5	27
13	>2 km SSW	Manitoba	27	34	1850	<.5	12
		Silver	7	29	1550	<.5	33
		MEAN	17	38	1900	<.5	30
ULN GUIDELINE***			50	-	4000	5	250

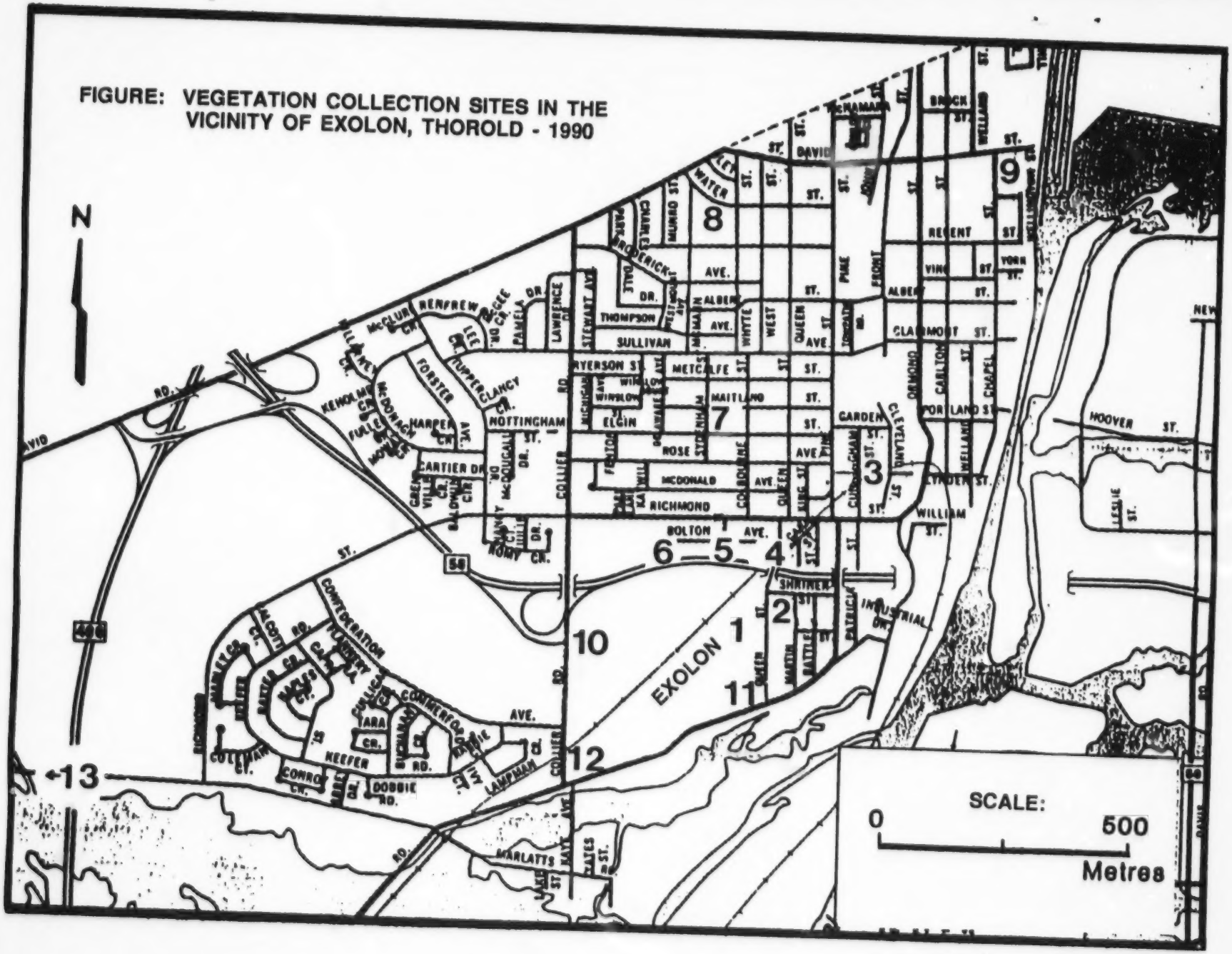
+ Distance from center of 2nd "O" In Exolon, see figure

* Average of duplicate sample results. ** Side opposite Exolon

*** Upper Limit of Normal (ULN) rural guidelines, see appendix. Exceedances are underlined

Note: In calculating means, "<" values were divided by two

FIGURE: VEGETATION COLLECTION SITES IN THE VICINITY OF EXOLON, THOROLD - 1990



APPENDIX

Derivation and Significance of MOE "Upper Limits of Normal" Contaminant Guidelines

The MOE "upper limits of normal" contaminant guidelines essentially represent the expected maximum concentration of contaminants in surface soil (non-agricultural), foliage (tree and shrub), grass, moss bags and or snow from areas of Ontario not subject to the influence of point sources of emissions. "Urban" guidelines are based upon samples collected from centers of minimum 10,000 population. "Rural" guidelines are based upon samples collected from non-built-up areas. Samples were collected by MOE personnel using standard sampling techniques (ref: Ministry of the Environment, 1983. Field Investigation Manual. Phytotoxicology Section - Air Resources Branch: Technical Support Sections - NE and NW Regions). Chemical analyses were performed by the MOE Laboratory Services Branch.

The guidelines were calculated by taking the arithmetic mean of available analytical data and adding three standard deviations of the mean. For those distributions that are "normal", 99% of all contaminant levels in samples from "background" locations (i.e. not affected by point sources nor agricultural activities) will lie below these upper limits of normal. For those distributions that are non-normal, the calculated upper limits of normal will not actually equal the 99th percentile, but nevertheless they lie within the observed upper range of MOE results for Ontario samples.

Due to the large variability in element concentrations which may be present across Ontario, even in background data, control samples should always be collected. This is particularly important for soils, which may show large regional variations in element composition due to difference in parent material. Species of vegetation which naturally accumulate high levels of an element also may be encountered.

It is stressed that these guidelines do not represent maximum desirable or allowable levels of contaminants. Rather, they serve as levels which, if exceeded, would prompt further investigation on a case by case basis to determine the significance, if any, of the above normal concentration(s). Concentrations which exceed the guidelines are not necessarily toxic to plants, animals or man. Concentrations which are below the guidelines are not known to be toxic.